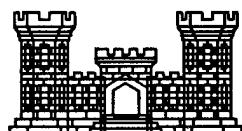


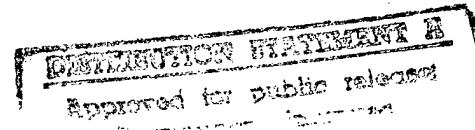
Water Conservation Study (Water and Energy)
Energy Engineering Analysis Program (EEAP) FY94S
Fort Knox, Kentucky

Final Report
EXECUTIVE SUMMARY

CONTRACT #DACA01-94-D-0034
SYSTEMS CORP PROJECT #94013.03
DECEMBER 30, 1994



Louisville District
US Army Corps
of Engineers



SYSTEMS*corp*

SYSTEMS ENGINEERING AND MANAGEMENT CORPORATION



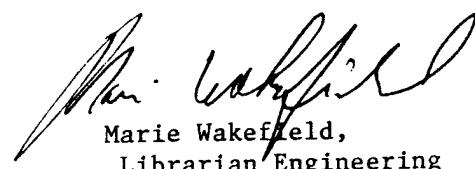
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1 EXECUTIVE SUMMARY

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1.1 SYNOPSIS

Systems Corp surveyed and completed water and energy analyses for 650 representative buildings at Fort Knox, categorized as unaccompanied personnel housing, community facilities, administrative facilities, maintenance facilities, training facilities, family housing, post laundry, hospital, heating plants, cooling towers, water treatment plants and water distribution systems. The water and energy conservation opportunities (ECOs) evaluated are listed in *Table 1.1*.

Cost estimates were prepared using MeansData for Windows Spreadsheets, Version 2.0a. Life cycle cost analyses were performed using the Life Cycle Cost in Design (LCCID) computer program. Project descriptions and DD1391 forms were prepared for four Energy Conservation Investment Program (ECIP) projects. The total of the four projects that were developed represent \$893K in annual savings and a total discounted savings of \$13.4M in the twenty year life of the projects. The simple paybacks average 5.6 years and the savings to investment (SIR) for the four ECIP projects average 2.8. In addition, three Federal Energy Management Program (FEMP) projects were developed. FEMP Project 1 is the replacement of all of the steam traps in the post laundry with a payback of 0.5 years and an SIR of 40. FEMP Project 2 is heating distribution system manhole repairs with a 3.4 year payback and an SIR of 5.5. FEMP Project 3 is the installation of wells to provide irrigation water for Lindsey and Anderson Greens with a 5.1 year payback and an SIR of 2.9.

1.2 INTRODUCTION

DTIC QUALITY INSPECTED 2

Systems Engineering and Management Corporation (Systems/Corp) was contracted by the Louisville District of the United States Army Corps of Engineers in August 1994 to perform a water conservation study of Fort Knox, Kentucky.

1.2.1 Scope of Work

1. Evaluate selected water and energy conservation opportunities (ECOs) to determine their water and energy savings potential and economic feasibility.
2. Conduct a limited site survey of selected buildings, family housing, heating plants, cooling towers and water distribution systems to insure any methods of water conservation which are practical and have not been evaluated in any previous study have been considered and the results documented.

TABLE 1.1 SUMMARY OF RECOMMENDED PROJECTS

PROJECT	INITIAL COST (\$)	ENERGY SAVINGS (MWH/HR)	SIMPLE PAYBACK PERIOD (YRS)	SIR	WATER AND MAINTENANCE SAVINGS (\$)
ECIP-FH1: Family Housing Water Conservation Phase 1	887,700	374	5.73	2.61	106,700
ECIP-FH2: Family Housing Water Conservation Phase 2	992,200		5.68	2.61	125,000
ECIP-FH3: Family Housing Water Conservation Phase 3	980,100		6.63	2.24	98,900
ECIP-4: Water Conservation Improvements to 452 Non-Family Housing Buildings	1,712,500	3,150	4.12	3.68	296,600
FEMP-1: Replacement of Steam Traps in Post Laundry	32,900	6,548	0.46	39.92	2,200
FEMP-2: Heating Distribution System Manhole Repairs	247,200	6,935	3.39	5.48	
FEMP-3: Golf Course Irrigation Well System	36,900	.9	5.13	2.90	7,603

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3. Determine efficiency of existing systems. Determine the replacement options with the highest SIR.
4. Provide complete programming or implementation documentation for all recommended ECOs.
5. Prepare a comprehensive report to document the work performed, the results, and the recommendations.

1.2.2 Organization of the Final Report

The submitted material for this report consists of the following:

Volume I: Executive Summary, Methods and Approach , ECIP Project 1, ECIP Project 2, and ECIP Project 3.
Volume II: ECIP Project 4.
Volume III: FEMP Project 1, FEMP Project 2, FEMP Project 3, and Appendices A-D.

1.3 PRESENT AND HISTORICAL WATER CONSUMPTION

The baseline water and energy consumption and the water and energy conservation opportunities were evaluated using spreadsheets to calculate water and energy consumption. These have been included in *Section 3 through 9* of this report.

The energy, water and sewage treatment costs used to calculate the savings for the project are as follows:

Cost/MBtu	
Electric	= \$0.02505/KWH or \$25.05/MWH
Fuel Oil	= \$5.05/MBtu or \$17.15/MWH
Natural Gas	= \$3.10/MBtu or \$10.51/MWH
Cost/Kgal	
Water	= \$0.9409/KGAL or \$0.249/Kliter
Sewage	= \$0.6292KGAL or \$0.160/Kliter

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1.4 ENERGY CONSERVATION OPPORTUNITIES INVESTIGATED

Systems Corp analyzed sixteen water and energy conservation opportunities (ECOs) at Fort Knox, Kentucky. The analysis was performed utilizing water and energy models developed by Systems Corp and data collected during the field survey of the facilities at Fort Knox. Each ECO was evaluated to determine the potential water and energy savings, dollar savings, implementation costs, simple payback, life cycle cost, and savings to investment ratio (SIR). The sixteen ECOs that were evaluated are as follows:

ECO-1	Spring-Loaded Faucets
ECO-2	Faucet Aerators
ECO-2FH	Faucet Aerators in Family Housing Units
ECO-3	Flush Valves for Water Closets
ECO-3FH	Water Closets in Family Housing Units
ECO-4	Flush Valve Retrofits for Urinals
ECO-5	Water Saving Showerheads
ECO-6	Dining Facility (Kitchen) Retrofits
ECO-7	Golf Course Irrigation
ECO-8	Post Laundry Retrofits
ECO-9	Water Treatment Plants and Well Field Motors and Pumps
ECO-10	Manhole Sump Pump Repairs
ECO-11	Sensor Controls
ECO-12	Water Heater Insulation Blanket
ECO-16	Ozone Treatment of Cooling Tower Water

Systems Corp's water and energy analysis models were used to determine the savings achieved for implementing each ECO in the facilities evaluated. MeansData for Windows Spreadsheets, Version 2.0a cost estimating software was used to estimate the implementation cost of each ECO in each facility evaluated. The U.S. Army Corps of Engineers' Life Cycle Cost in Design, Version 1.0, Level 92, software was used to perform life cycle cost analyses and determine the SIR of each ECO for each facility evaluated.

1.4.1 ECOs Recommended

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Systems Corp recommended both ECOs evaluated be implemented, but not in every area surveyed. The following is a list of the ECOs recommended to be implemented by area surveyed. The criteria for recommendation is a favorable simple payback, and savings to investment ratio (SIR).

ECO-1	Spring-Loaded Faucets
ECO-2	Faucet Aerators
ECO-2FH	Faucet Aerators in Family Housing Units
ECO-3	Flush Valves for Water Closets
ECO-3FH	Water Closets in Family Housing Units
ECO-4	Flush Valve Retrofits for Urinals
ECO-6	Dining Facility (Kitchen) Retrofits
ECO-7	Golf Course Irrigation
ECO-8	Post Laundry Retrofits
ECO-10	Manhole Sump Pump Repairs

1.4.2 ECOs Rejected

ECO-9, 11, 12, and 16 were rejected due to the large investment required, the low potential savings, or the existence of a more economically feasible technology. Refer to Appendix D for The Life Cycle Cost Analyses, Cost Estimates and Calculations.

1.4.3 ECIP and FEMP Projects Developed

Systems Corp developed four ECIP projects and three FEMP projects (see Table 1.4.3). ECIP Family Housing Project 1 consists of the replacement of water closets in 1354 family housing units with water saving, 6-liters (1.6 gallons)-per-flush water closets, and the installation of faucet aerators in 328 family housing units. ECIP Family Housing Project 2 consists of the replacement of water closets in 1602 family housing units with water saving, 6-liters (1.6 gallons)-per-flush water closets. ECIP Family Housing Project 3 consists of the replacement of water closets in 1268 family housing units with water saving, 6-liters (1.6 gallons)-per-flush water closets. ECIP Project 4 consists of the replacement of flush valves and faucets in 452 buildings with water saving flush valves, metering valve faucets and the installation of faucet aerators. FEMP Project 1 consists of the replacement of all of the steam traps in Building 18, the Post Laundry. FEMP Project 2 consists of the repairs to the heating distribution system manholes for the underground distribution systems serving boiler plants in the following buildings: Buildings 852, 1537, 1725, 1731, 1785, 1797, 2780, 5213, 5943,

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6615 and 7203. FEMP Project 3 consists of disconnecting the existing potable water supplies and drilling two wells, one each for the Lindsey and Anderson golf courses.